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# Microeconomic Efficiencies and Macroeconomic Inefficiencies: On Sustainable Fisheries Policies in Very Poor Countries

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ABSTRACT *Simple macro-models are used in a two good output spaces to show that, under certain conditions that occur in very poor countries, fisheries policies aimed at concentrating rent and rationalizing excess capacity may result in declines in economic growth. In cases where displaced labour has nowhere else to go, such policies may be welfare decreasing for the country as a whole. The second best policy in these cases would be to encourage open access fishing with controls on overall output. An example based upon information gathered on the shrimp fishery in Madagascar describes the relations between the relative price between artisanal and industrial fishing sectors, and differential effects of the leakage of rents through the net exports equation due to policies favouring capacity rationalization.*

## 1. Introduction

Many fisheries of developed countries have had common pool management institutions that have led in many cases to the growth of excess capacity and the dissipation of resource rents. This excess capacity places stress on natural stocks, which may not be resilient enough to support it. Fisheries economists have proposed policies aimed at reducing the excess capacity in the fishery. Another related policy that is frequently discussed is rent extraction. The reasoning goes that once limited licensing and individual quotas are put in place, the government should extract rents from the fishery through competitive systems of

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licence attribution, in part to put resource rents to other uses and in part to slow down capital formation in the fishery. The holder of the fishing right, the fisherman, retains a normal profit, but the resource rent is taken and used by the State. Although in actual practice rent extraction is not widespread, both the theory and the reasoning of rent extraction have caught the attention of development economists as a possible way of financing the restructuring of developing countries.

These ideas from classical fisheries economics, however, now contend with another major development in economics over the late 20th Century. Institutional economics ideas have provided a complementary theoretical framework for the re-examination of the so-called tragedy of the commons. These ideas have been applied to fisheries and other common pool resources (Coase, 1970; Wilson, 1982; Anderson & Hill, 1983). This early work culminated in a rich literature on commons management, which has argued, among other things, that although the negative effects of open access use of fish stocks and other public goods are possible, the condition may be less common than supposed, and can possibly be managed sustainably as common property (Ostrom, 1990; Feeny *et al.*, 1990, 1996; Bromley, 1992; Ostrom *et al.*, 1999; Berkes, 2005). These points of view have become potent counter-arguments to the classical results of fisheries economics of the 1970s and 1980s. Economists from this main branch of thought often ask questions about the real efficiencies of simulating a sole owner solution, given the pre-existing resource-conserving incentives of residual claimants, and the real ability of some public managers to overcome their own internal transactions and organizational costs. In effect, institutional economists often ask whether commons management is really as inefficient as we suppose, and they often ask questions about the real management efficiencies promised by traditional public management.

As for rent capture, most public managers in developed countries realize that it is easier said than done (Boyd & Dewees, 1991; Pearse & Walters, 1992; Squires *et al.*, 1995). Grafton (1995a,b, 1996) has written extensively on rent capture and taxation in rights-based fisheries, and offers similar cautions. The possibility of rent capture and how to do it in different contexts raises practical questions as well. Do we even need to do it in countries with progressive income tax and capital gains tax? To what end will the collected rents be used? How much productive capacity will be displaced, and what are the costs of retooling this productive capacity compared with the rents captured? Finally, are public management institutions really equipped to manage the effort and to deal with the practical consequences of rent accumulation and management? These are straightforward issues for managers in developed countries. However, when the debate is taken to developing countries, it becomes extremely delicate and complex (Wilson, 1998, 2007).

Most fisheries economists understand the various issues related to the theory of rent generation, dissipation and capture. However, economists working for development agencies seem attracted to the idea that an important element of efficient resource management is rent capture, and seek to build these features into restructuring programmes in poor countries. These ideas come mainly from the literature on fisheries economics from the 1970s and 1980s, exemplified by, for example, Cunningham *et al.* (1985). Modern expressions of these ideas can be found in discussion documents of the World Bank (2004) and the OECD (2006), for example. The difficulty lies, however, in the practical effects of promoting rent concentration in poor and institutionally weak countries. If difficult in developed countries, why would it be easier in developing countries?

Some interesting lines of research run parallel to the debates among fisheries economists. The resource curse (RC) literature (Auty, 1990; Sachs & Warner, 1997, 2001) has shown a negative relationship between resource endowments and the rate of economic growth using cross-section data across countries. The work by Sachs and Warner in particular suggests that comparatively large resource endowments pull factors of production to economic activities that contribute to lower rates of economic growth. Some of these studies, also using cross-sectional data, have related economic growth to indices of institutional performance and governance in countries (Mehlun *et al.*, 2006). These studies argue that weak public management institutions can give rise to the resource curse. This work is part of the larger research agenda on measuring institutional performance, public sector efficiency, transparency in governance, and resistance to corruption. This agenda has taken on increased importance since it has been argued that these issues will have an impact on the success of country restructuring programmes (Burnside & Dollar, 2000, 2004a,b).

It is therefore important for us to situate our work in the context of the RC literature and institutional performance at the outset, because the problems we describe are relevant to many least-developed countries (LDCs) that are rich in natural resource endowments, but which may be institutionally weak. Most of the RC literature has searched for causal effects between various measures of institutional performance, resource endowment, and rates of economic growth using cross-sectional data and econometric techniques. The evidence so far supports, with varying degrees of certainty, the idea that a resource curse phenomenon exists, and that the quality of public management institutions plays a role (but see Sachs, 2003). However, there are few structural models to date that explain how and why growth slowdowns and declines occur, and most of the statistical models from this literature, although they invite fruitful conjecture and debate, are not structural in nature. This is in part because the supporting data are usually scarce for poor countries at the sector level.

The national income accounts of most countries, however, follow the structure of simple macroeconomic models. It therefore seems reasonable to use this structure to explain growth declines. As we explain later, if the quality of public institutions does not inspire confidence in their ability to capture and use rents efficiently, and leads to leakage of these rents outside the country, then another sector of the economy with less leakage might be favoured.

These debates also take on more meaning when discussed in the context of public management of sectors such as fisheries in poorer countries, where the public management institutions are sometimes characterized as weak. These countries share a number of conditions that developed countries may not have. Fisheries are relatively more important in many poorer countries. Of 49 LDCs, nearly 31% of them cite fisheries or fish products as part of the top three exports of the country (UNCTAD, 2002). A comparatively greater part of the diet in animal protein in LDCs comes from fish, and it is particularly the poorer nations that report consumption rates for fish of over 20% (FAO, 2004). These same countries usually have large numbers of subsistence and small entrepreneurs involved in fisheries who have many economic functions within their own communities. Many poorer countries must provide an attractive environment for foreign investment while maintaining a viable tax structure to generate public revenues. They also must fight against corruption and rent seeking by public servants, just as in developed countries. All of these activities can imply important organizational costs.

This paper uses structural macroeconomic models to explain why the main recommendations of fisheries economists, capacity reduction and rent extraction, may not be efficient policies for poor countries with weak public management institutions. We shall motivate this proposition in two ways. First, we use a hybrid of a bio-economic model from fisheries and a classical Keynesian model. The fisheries model is based upon the standard assumptions outlined by Gordon (1954) and Scott (1955), later presented in numerous texts in fisheries economics, of which Cunningham *et al.* (1985) is but one example. Then we discuss a case in which information was collected on the macro-effects of the industrial and the artisanal shrimp fishery in Madagascar, as presented in various reports that dealt with the problem.[1] Section 2 discusses the problem graphically, Section 3 develops the ideas mathematically and Section 4 presents a case study of the Madagascar shrimp fishery. This is followed by a discussion and conclusion.

We examine the economic growth characteristics of a country with an industrial fishing sector where rents are concentrated. However, the marginal propensity to consume directly unproductive imports from these rents is large. We compare this industrial structure with an open access traditional industrial structure with higher employment potential. In presenting the model and the case study, we are aware that we are raising questions about the pertinence of the rent dissipation argument as a motivation for public management. This is intentional. The preoccupation with rent dissipation in the resources literature is perhaps most justified in the case where an economy is perfectly competitive, having no trade barriers at all with the rest of the world, and where all forms of capital flight are possible. In these cases, one could say that the economy is “porous” with regard to rents. Resource rents may not simply be dissipated into the economy, but entirely out of the country. However, if resource rents are dissipated or “leaked” into a more complex and realistic economy full of imperfect competition and transactions costs, then rent leakage at one level may be “trapped” at other levels in the economy, where it can be translated into investment and a reduction in the unemployment rate. This is especially true under an extreme Keynesian assumption of a flat short-run aggregate supply curve. Second, overcapacity arguments, and the need to reduce overcapacity, are more delicate issues in poorer countries. Although there is still a need to think about where overcapacity will be less damaging within the alternatives available to the labour considered, such alternatives could often be severely limited in poorer countries.

## 2. Graphical Introduction

In Figure 1, there are two sectors. Sector 1 is the fishery, represented by an aggregate total revenue function, based upon a sustainable yield curve, derived from the logistic growth of a resource stock.[2] Sector 2 is the rest of the economy. In sector 1, the variable $N_1$ is interpreted conjointly as effort and employment.[3] It is exogenous, and subject to the fisheries policies of the country. We consider two policies (or groups of policies) leading to two main outcomes. On the one hand we have policies that result in a simulation of the sole owner solution ($N_1$*, $Y_1$*), where the public managers and the members of the industry maximize rent, divide it up, and then remove it from the country. Alternatively, rents may be entirely dissipated at the fishery level into the local economy at the open access equilibrium ($N_1$** $Y_1$**). For simplicity, we assume that the outputs of the fishery sector are exported entirely.

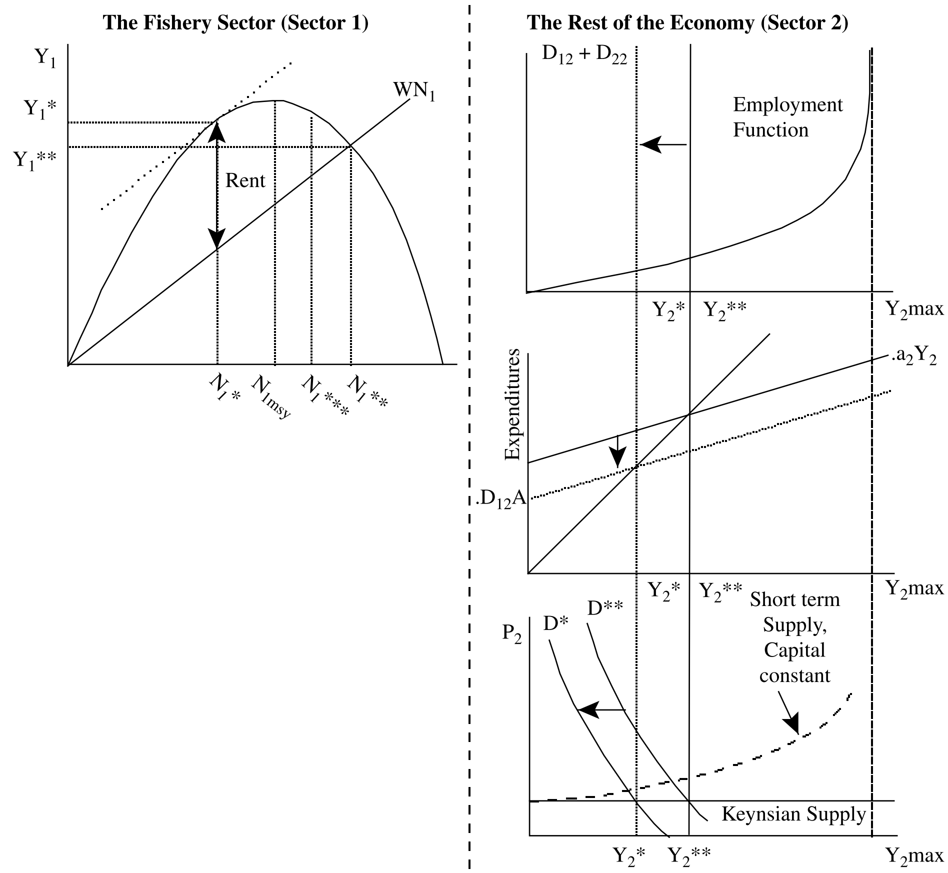


**Figure 1.** Employment-led growth in a two-sector economy with an exhaustible resource sector. *Note:* Would a move from open access ($N_1$**) to a micro-economically "optimal" position ($N_1$*) lead to growth or decline in Sector 2? That depends on the mobility of labour, and the fate of the rent that is generated as a result of the policy. If short-term demand declines, the net result of such policies on the economy could be negative. This may suggest a third employment level ($N_1$***) that would be "optimal" from a macro-economic point of view; or no move from ($N_1$**) at all.

Employment and output in sector 1 will have an impact on the macroeconomics of sector 2. This will have an impact on aggregate demand in the economy. As consumption, investment, public spending and net exports change, projected expenditures and therefore aggregate demand in sector 2 change as well. If the short-run supply curve of sector 2 is flat to the point at which full employment or potential GDP occurs, aggregate demand moves with no change in the price level $P$, at least until that point is reached. If the short-run supply is not flat, but is asymptotic to some maximum short-run output, then there will be negative feedback to sectors 1 and 2, through that part of $W$ that is affected by $P$ and the part of $R$, the rents, which will also be affected by $P$. Employment in sector 2, $N_2$, is endogenously determined indirectly by the output in sector 1 and directly by the output in sector 2 through the employment function. If different policies change $N_1$, and therefore other macroeconomic variables in the economy, then it makes sense to ask whether there is not a third possible equilibrium (call it $N_1$***, $Y_1$***), which would be desirable from

a macroeconomic standpoint. Such modelling might be useful to review trade-offs of different policies by looking at the mechanics of economic growth, and the assumptions that govern these mechanics.

## 3. The Basic Model

Most fisheries analyses are presented as partial equilibrium exercises and assume the approximate efficiency of management (Hannesson, 1993). However, the assumption of efficient management may not apply, and partial equilibrium approaches may at times be inappropriate. This model illustrates that intuition, and the conditions under which it is valid. It uses two simple models commonly used in economics. One is the fisheries model based upon the assumptions of Gordon and Schaefer, and the other is the Keynesian model of an open economy in short-term equilibrium, as presented by Muet (1990). The two models describe the fisheries sector (sector 1) and the rest of the economy (sector 2).

Labour is the abundant factor in this economy, as shown in Figure 1, and as implied by the strong Keynesian assumption. Although not explicit in our model, labour markets may be segmented in poor countries. The fishery has been called an employment of last resort, when labour is particularly abundant for different social and economic reasons.[4] Fishermen are therefore prevented from selling labour services elsewhere, and are squeezed from below by the general tendency towards an equilibrium subsistence wage, with resulting surplus labour. If sector 1 employment increases, thus pushing out aggregate demand in sector 2 without an increase in the price level, then labour is not a binding constraint to growth. Access to fisheries resources can in principle be controlled through policy,[5] which is why $N_1$ is an exogenous variable.

### *3.1 The Fisheries Sector (Sector 1)*

The sustainable fisheries production $Y_1$ is described using an aggregate production function based on the Schaefer model. Employment in the fishery ($N_1$) is taken as an index of effort in the fishery, where $N_{1\text{msy}}$ is the employment associated with maximum sustained yield (MSY) in the fishery:

$$Y_1 = f(N_1);\; f''(N_1) < 0;\; f'(N_1) >=< 0 \quad \text{as} \;\; N_1 <=> N_{1\text{msy}}. \tag{1}$$

For simplicity, assume that the entire production of sector 1 is exported, and is the only export ($X$) of the country, such that $X = Y_1$. Exporters are price takers on the world market, implying that we are using a small country assumption, which is appropriate for many LDCs. High-valued marine species, such as shrimp, tend to be exported. Part of this may be due to the application of export-led growth arguments, which seem to underpin much of development policy in LDCs. $W$ is the wage for effort. The value $WN_1$ is entirely spent on goods. The marginal propensity to consume domestic goods is $a_w$ $(0 < a_w < 1)$. The marginal propensity to use resource rents for domestic and import consumption is $a_R$ $(0 < a_R < 1)$. The rest of $WN_1$ buys import items. The fisheries rent is $R = Y_1 - WN_1$. Rents are maximum at $N_1*$ and zero at $N_1**$ (Figure 1, sector 1). The employment $N_1**$ corresponds to "sustainable open access".

The aggregate domestic demand $D_1$ from sector 1 and the import demand $M_1$ is:

$$D_1 = a_w W N_1 + a_R R; \tag{2}$$

$$M_1 = (1 - a_w) W N_1 + (1 - a_R) R. \tag{3}$$

We do not explicitly treat consumer saving, in part to simplify the exposition and in part because we think the marginal propensity to save in many poor countries is relatively small. We have not considered the marginal propensity of taxation, in part to keep the exposition tractable and in part because many LDCs do not have tax infrastructures that allow a clear measurement of these effects.

It is also important to point out that some governments of poor countries may encourage variants of the sole owner solution, partly to avoid the costs of management and partly to impede the dissipation of rents into the economy by concentrating them in the hands of fewer actors, who can then be exploited more easily by government officials. Therefore, we cannot say *a priori* that a poor country is likely to be more "open access" or more privatized, and finding one or the other condition in the field would not be particularly surprising.

### *3.2 The Rest of the Economy (Sector 2, Figure 1)*

The employment $N_2$ in the rest of the economy (sector 2) depends upon the level of national production $Y_2$:

$$N_2 = g(Y_2); \quad g'(Y_2) > 0. \tag{4}$$

National production in sector 2 depends on demands generated by sector 1 and sector 2. In equilibrium, $Y_2 = D_1 + D_2$. The demand from sector 2 has an autonomous ($A$) and an induced element:

$$D_2 = a_2 Y_2 + A \quad (0 < a_2 < 1). \tag{5}$$

The parameter $a_2$ is the marginal propensity to consume goods in sector 2. The demand for output-induced imports in sector 2 is:

$$M_2 = m_2 Y_2 \quad (0 < m_2 \leq 1 - a_2). \tag{6}$$

The parameter $m_2$ is the marginal propensity to import in sector 2. The external trade balance is $S = X - M_1 - M_2$.

### *3.3 The Structural Model and its Reduced Form*

Table 1 shows the structural model of 10 equations describing the endogenous variables. We investigate the impact of the choice variable $N_1$ on aggregate demand through $D_1$ and the impact that redistributions may have on $Y_2$ through the net export equations. A simplification of sector 1 is:

$$D_1 = a_R f(N_1) + (a_w - a_R) W N_1 \tag{7}$$

$$M_1 = (1 - a_R) f(N_1) - (a_w - a_R) W N_1. \tag{8}$$

**Table 1.** The structural model and definitions of the endogenous variables.

| Equation | Description |
|---|---|
| $Y_1 = f(N_1)$ | Aggregate fisheries production |
| $X = Y_1$ | Exports equation |
| $R = Y_1 - WN_1$ | Fisheries rent |
| $D_1 = a_w WN_1 + a_R R$ | Demand from sector 1 to sector 2 |
| $M_1 = (1 - a_w)WN_1 + (1 - a_R)R$ | Import demand from sector 1 |
| $N_2 = g(Y_2)$ | Employment function, sector 2 |
| $Y_2 = D_1 + D_2$ | Aggregate demand to sector 2 |
| $D_2 = a_2 Y_2 + A$ | Sector 2 demand for sector 2 products |
| $M_2 = m_2 Y_2$ | Import demand from sector 2 |
| $S = X - M_1 - M_2$ | Net exports equation |

The following exogenous variables and parameters are used:
$N_1$ = Fisheries employment ($0 \leq N_1 \leq N_1^{**}$);
$W$ = The wage of fishermen ($W > 0$);
$A$ = Autonomous demand in sector 2 ($A > 0$);
$a_w$ = Propensity of the fishing sector to consume products from sector 2 ($0 < a_w \leq 1$);
$a_R$ = Propensity of rent holders to consume products in sector 2 ($0 \leq a_R < a_w$);
$a_2$ = Propensity to consume sector 2 products by sector 2 ($0 < a_2 < 1$);
$m_2$ = Marginal propensity to import ($0 < m_2 \leq 1 - a_2$).

In this model, the partial trade balance equation is the sector 1 demand:

$$X - M_1 = f(N_1) - (1 - a_R)f(N_1) + (a_w - a_R)WN_1 = a_R f(N_1) + (a_w - a_R)WN_1 = D_1. \quad (9)$$

The variables $Y_2$, $D_2$, $M_2$, $N_2$ and $S$ are also explained in terms of $D_1$:

$$\begin{aligned} Y_2 &= (D_1 + A)/(1 - a_2) \\ D_2 &= (a_2 D_1 + A)/(1 - a_2) \\ M_2 &= (D_1 + A)m_2/(1 - a_2) \\ N_2 &= g[(D_1 + A)/(1 - a_2)] \\ S &= X - M_1 - (D_1 + A)m_2/(1 - a_2). \end{aligned} \quad (10)$$

Substituting $(X - M_1)$ with $D_1$ we obtain $S = [D_1(1 - a_2 - m_2) - Am_2]/(1 - a_2)$. The equations for the rest of the economy can be re-expressed as functions of $N_1$:

$$\begin{aligned} Y_2 &= [a_R f(N_1) + (a_w - a_R)WN_1 + A]/(1 - a_2) \\ D_2 &= \{[a_R f(N_1) + (a_w - a_R)WN_1]a_2 + A\}/(1 - a_2) \\ M_2 &= [a_R f(N_1) + (a_w - a_R)WN_1 + A]m_2/(1 - a_2) \\ N_2 &= g\{[a_R f(N_1) + (a_w - a_R)WN_1 + A]/(1 - a_2)\} \\ S &= [(a_R f(N_1) + (a_w - a_R)WN_1)(1 - a_2 - m_2) - Am_2]/(1 - a_2). \end{aligned} \quad (11)$$

### *3.4 Discussion of the Results*

The aggregate demand generated by sector 1 features in all of the reduced-form equations for $Y_2$, $D_2$, $N_2$, $M_2$ and $S$. Further, these functions are increasing in $D_1$. Therefore, we look at the impact of changes in $N_1$ on $D_1$. Taking the derivative of $D_1$ with respect to $N_1$, we obtain:

$$\mathrm{d}D_1/\mathrm{d}N_1 = a_R f'(N_1) + (a_w - a_R)W. \tag{12}$$

The function $f'(N_1)$ is the marginal productivity of labour in the fishery and $(a_w - a_R)W$ is the wage rate weighted by the difference in the propensities to consume in sector 2 by the fisheries sector and rent holders. This derivative is greater than zero when $f'(N_1) > (1 - a_w/a_R)W$, is zero when these values are equal, and is negative when $f'(N_1) < (1 - a_w/a_R)W$.

The growth in the economy varies directly with the employment in the fisheries sector as long as $f'(N_1)$ is greater than $(1 - a_w/a_R)W$. However, $a_w > a_R$, for reasons that we see in the field. This means that under reasonable conditions found in many poor countries, policies that favour employment in the fisheries sector may be preferred, from a macroeconomic point of view, to the recommendations of either biologists or fisheries economists. The macroeconomic "optimum" would appear always to be in a range where $f'(N_1) < 0$, or the range of sustainable biological overexploitation, except for the case where $W = 0$, or when $a_w = a_R$, in which case $f'(N_1) = 0$. When the marginal productivity of labour falls below this level, the situation is reversed. The level of employment that maximizes the economic activity in the rest of the economy as well as the trade balance is $N_1{*}{*}{*}$, such that $f'(N_1{*}{*}{*}) = (1 - a_w/a_R)W < = 0$.

The main results are shown in Figure 1, sector 1. In this diagram, we have drawn the static bio-economic optimum for $N_1{*}$, the point of maximum biological production $N_{1\mathrm{msy}}$, the open access equilibrium $N_2{*}{*}$ and a "macroeconomic optimum" ($N_1{*}{*}{*}$).

At $N_1{*}, f'(N_1{*}) > 0$. This implies that for non-negative $W$, $a_w < a_R$. Assuming that the marginal propensity for the fishing sector to consume sector 2 products ($a_w$) is positive and less than the propensity of rent seekers to consume domestic goods (also positive), the "macroeconomic optimum" ($N_1{*}{*}{*}$) could be found to the left of MSY, in the vicinity of $N_1{*}$. Another way of thinking about this is to note that as $a_w$ and $a_R$ are defined, $f'(N_1{*}{*}{*}) < W$, but at the bio-economic optimum, $f'(N_1{*}) = W$, by definition. This means that $N_1{*} < N_1{*}{*}{*}$.

With chronic unemployment, the level of employment in the fishery that maximizes the national revenue in the rest of the economy, and which will contribute most to the balance of trade, is larger than the employment that maximizes resource rent. The case where rent holders end up having an equal or higher marginal propensity to consume domestic goods than the rest of the economy seems unreasonable. One problem of poorer countries is somehow to encourage resource users to reinvest in the economy. This is made difficult not only by a relatively small market basket available to consumers, but also by policies that encourage capital flight and corruption.

The question of long-term and short-term adjustment between the two sub-models is not at issue in this discussion. In fisheries, adjustments to the competitive or "open access" equilibrium are often discussed as long term, whereas macro-adjustments to fiscal policy are often followed on a quarterly or even on a monthly basis. On the other hand, adjustments to a rent-maximizing employment position in the fishery can be very rapid.

We have constructed the model such that sector 1 employment policy is assumed to lead immediately to changes in $N_1$, which leads to subsequent adjustments in the rest of the economy. The production in each sector is autonomous with respect to time, and therefore should be interpreted as structural, although the model could be extended to permit a more explicit treatment of economic dynamics.

## 4. The Model at Work: A Case Study from Madagascar with a Segmented Industry

### *4.1 The Problem*

Madagascar is an example of a very poor country that is blessed with natural resources. The resources currently discussed in the literature are biodiversity, but the country also has impressive mineral wealth, a capacity for producing high-valued and exotic agricultural goods (such as spices and essences from flowers), as well as an Exclusive Economic Zone that is highly attractive for fishing. In particular, the shrimp fishery has accounted in the past for as much as 11% of the GDP of the country. Yet, according to World Bank statistics for 2004, Madagascar is the seventeenth poorest country in the world in terms of GDI per capita. Also, during the period of this case study (1998–99), the country also ranked below the average out of 207 countries using World Bank indices related to institutional performance[6] in Political Stability ($-0.28$), Government effectiveness ($-0.45$), Regulatory quality ($-0,46$), Rule of Law ($-1.01$) and Control of Corruption ($-0.80$). The mean for these indices is zero, and the scoring range is $+2.5$ to $-2.5$.

In the fishery, this ex-colony of France had, even after independence, extensive support from the French Institut de Recherche pour le Développement, or IRD, in the form of mapping and evaluation of fisheries resources in the various zones along the East and West coasts of the island. After independence in 1960, these zones were managed by the Minister of Fisheries of Madagascar. The new ministry was responsible for the task of taking over the public management of 4800 km of coastline, used not only by local fishermen but also by guest fishing nations. One solution that evolved from this situation was the granting of "exclusive use rights" to some highly productive coastal areas in the northwest part of the island to private firms for shrimp fishing, beginning in the early 1970s. Later, these arrangements extended to other parts of the island. In interviews the first author had with most of the principals in this case in 1999, it was discovered that although there was little written evidence of formal transfer of these zones to the companies in question, there was nevertheless a presumption that these zones were under the management of the dominant companies in these zones, in exchange for a user fee. These user fees were apparently collected at both the official level and informally. The payments assured the validation of the boat licences for fishing.

As the country and the fishery evolved, these rights structures began to be challenged. In the early 1990s, with declining national income and increasing poverty, a large number of artisanal and traditional fishermen began to use all zones to make a livelihood, including the "privatized" zones on the Northwest and East coasts of the island. Traditional fishing was not controlled at the national level, although it may have been under some local control (Breton *et al.*, 1998) by village government, at least at the beginning. By most accounts, the traditional and artisanal fisheries fuel local consumption as well as a second export market for shrimp products to countries with less rigorous sanitary standards. This competitive export branch was organized by "collectors", who made regular stops

at villages of mainly traditional fishermen. In addition to this, other industrial fishing firms, recognizing the benefits of managing zones exclusively, began to demand similar types of arrangement from the Minister of Fisheries, and others even began to challenge the exclusive zonal access rights of the more established (and dominant) firms.

There is ample anecdotal evidence from reliable sources that during this period of transition industrial fishing power increased outside the zones, and that the level of bribes extracted from companies to maintain their permits within the zones increased as well. In addition, the fisheries minister at the time began to cancel permits for certain firms, which were then given or sold to other firms. This was often done on the pretext of various administrative infractions committed by the firm, or nationalization of the resource. Some firms who faced expropriation of their permits were viewed as foreigners.

The dominant industrial fishing firms claimed that the Malagasy government benefited for years from a sustainable management of an extremely rich fishery. This claim is difficult to refute, and interviews with the heads of the dominant firms at the time reveal that considerable effort was applied to understanding the life cycle of the shrimp species in the area, so that the timing of fishing operations would coincide with sizes of shrimp that would maximize profits for the firms. This observation supports the classic argument in fisheries economics using the static partial equilibrium analysis. The sole owner rent-maximizing solution resembles that of a monopolist who charges a single price for the output. This resulting behaviour is resource conserving. This arrangement also provided employment, infrastructure and hard currency through exports, as well as revenues to the government officials, at both an official level and an unofficial level. Further, shrimp captured by some artisanal methods and by most traditional methods are smaller and/or inferior in quality due to handling, thus commanding lower prices. The traditional methods in particular are considered by many to be unsustainable as well. Finally, it was argued that it would be difficult to imagine a common pool traditional fishery that would manage the resource in such a way that would lead to the capture of revenues, especially as this sector is extremely difficult to manage publicly because of large numbers of fishermen and their relative isolation.

By the late 1990s the debate had intensified into one of nationalization of the resource. The industrial fishing firms felt that not only were the property rights arrangements changing under their feet, but also that these changes were being abetted by nationalist rhetoric. The government suspected activities aimed at avoiding the payment of the agreed licence fees, and avoiding the export tax on shrimp products leaving Madagascar. The government claimed that there was significant size under-grading aimed at minimizing the declared value of the export, transhipment at sea, transfer pricing, and other practices that contributed to leakage of value out of the country.

These debates culminated in a number of studies and workshops aimed at resolving the conflicts between the government, the industrial sector, the artisanal sector and the traditional sector. The artisanal sector in Madagascar is composed of smaller-scale Malagasy fishermen who use modern fishing techniques. They are in some sense aspiring industrial fishermen. One output from these debates was the report by Griffin *et al.* (1998), which outlined the problem and possible solutions to the conflict, some of which also became part of the conditions for a World Bank restructuring plan for Madagascar.[7] The second principal output was the conference proceedings of a joint meeting between the government of Madagascar and representatives of the artisanal, traditional and the industrial sector. The third output was a study of the partial equilibrium impacts of the

industrial sector and the traditional sector on the economy of Madagascar (GAPCM & SEPIA, 1998a–c), as well as studies on the question of tax avoidance and leakage of added value. This collected work is important, because it permits a rare glimpse of this economic sub-sector at the time. We use some of the results of this study further on.

### *4.2 The Problem in Model Form*

Reflecting the realities of the case study, we introduce the idea of two fleets using two different technologies; one using industrial or modern technologies, and the other using traditional or subsistence techniques.[8] To gain more intuition about the policy dilemma, we assume the production function in equation (1) is based upon a logistic growth function:

$$\mathrm{d}B/\mathrm{d}t = rB(1 - B/B_{\max}), \tag{13}$$

where $B$ is stock biomass, $B_{\max}$ is carrying capacity and $r$ is the intrinsic rate of growth of the stock. Fishing effort is proportional to employment or $N_1$. In addition, two alternative technologies and sectors exist for fishing: traditional (I) and industrial (II), each having different production parameters (called "capturability coefficients" in fisheries), $q_i$, such that $q_{\mathrm{I}} < q_{\mathrm{II}}$.

Equilibrium production under each alternative technology is $Y_{\mathrm{i}} = \mathrm{d}B/\mathrm{d}t$, such that:

$$Y_i = f_i(N_{1i}) = B_{\max}\, q_i N_{1i}\,(1 - q_i N_{1i}/r). \quad (i = \mathrm{I}, \mathrm{II}). \tag{14}$$

The maximum production under either technology is the same, or $0.25rB_{\max}$. However, both the employment at this maximum, $N_{1i.\mathrm{msy}} = 0.5r/q_i$, as well as the employment that drives equilibrium yield to zero, $N_{1i.\max} = r/q_i$, will be different depending upon the technology (I or II). Owing to the capturability coefficients, these two employment values for the traditional sector would lie above those of the industrial sector. In the actual case study, these two sectors coexist with each other. However, an important preoccupation underlying these debates was whether one sector would contribute more to the economy than another sector. Our analysis therefore reflects this aspect of the debate.

*4.2.1 Fishing costs and fisheries rents.* To start, we assume the world price is the same and unitary for both technologies[9] ($P = 1$). Our unit cost $W_i$ is still the cost of effort, but it is different according to the technology under consideration ($i = \mathrm{I}, \mathrm{II}$). Rent can then be described as before: $R_i = f_i(N_{1\mathrm{i}}) - W_i N_{1\mathrm{i}}\,(i = \mathrm{I}, \mathrm{II})$. However, $W_{\mathrm{I}} < W_{\mathrm{II}}$ and $W_{\mathrm{I}}/q_{\mathrm{I}} > W_{\mathrm{II}}/q_{\mathrm{II}}$, which means that the industrial sector is technically more efficient in terms of costs per unit of effort.

From the bio-economic equilibrium conditions, we can say that $R_i = q_i B N_1 - W_i N_1$ ($i = \mathrm{I}, \mathrm{II}$), and the difference between the rents under the two technologies can be described as:

$$R_{\mathrm{II}} - R_{\mathrm{I}} = B(q_{\mathrm{II}} N_{1\,\mathrm{II}} - q_{\mathrm{I}} N_{1\,\mathrm{I}}) - (W_{\mathrm{II}} N_{1\,\mathrm{II}} - W_{\mathrm{I}} N_{1\,\mathrm{I}}), \tag{15}$$

where $N_{1\mathrm{I}}$ and $N_{1\mathrm{II}}$ is the employment under each technology.[10]

*4.2.2 Possible equilibria in the fishery.* Policy-makers at the time therefore faced two extremes between which they, for reasons that have been explained above, tried to strike some sort of balance. These are common pool solutions and rent-maximizing solutions.

For each technology, we can look at output, employment, cost and rent characteristics. These are:

(1) The rent-maximizing points ($N_{1i}$*, $Y_{1i}$*):

$$N^*_{1i} = (0.5r/q_i)(1 - W_i/q_i \cdot B_{\max}) \quad (i = \mathrm{I}, \mathrm{II}) \tag{16}$$

$$Y^*_{1i} = (0.25r \cdot B_{\max})(1 - W_i^2/q_i^2 \cdot B^2_{\max}) \quad (i = \mathrm{I}, \mathrm{II}). \tag{17}$$

(2) The rent dissipating points ($N_{1i}$**, $Y_{1i}$**):

$$N^{**}_{1i} = (r/q_i)(1 - W_i/q_i \cdot B_{\max}) \quad (i = \mathrm{I}, \mathrm{II}) \tag{18}$$

$$Y^{**}_{1i} = (rW_i/q_i)(1 - W_i/q_i \cdot B_{\max}) \quad (i = \mathrm{I}, \mathrm{II}) \tag{19}$$

(3) The costs and the rents at the rent-maximizing equilibria:

$$W_i N^*_{1i} = (0.5r/q_i)(1 - W_i/q_i B_{\max}) \quad (i = \mathrm{I}, \mathrm{II}) \tag{20}$$

$$R^*_i = Y^*_{1i} - W_i N^*_{1i} = (0.25r\,B_{\max})(1 - W_i/q_i B_{\max})^2 \quad (i = \mathrm{I}, \mathrm{II}). \tag{21}$$

Public managers in poor countries may seek to put policies in place that favour rent maximization by an industrial sector with a small number of easily identified operators, in order more easily to capture rents themselves by various means. However, these same countries have important reserves of human capital that perform traditional fishing activities. The transaction costs for managing this fishery are often thought to be prohibitive, thus leaving it in a common pool situation. For these reasons, we consider these two regimes in the fishery: traditional techniques (I) in an open access regime (at $N_{1\,\mathrm{I}}$**, $Y_{1\,\mathrm{I}}$**); and industrial techniques (II) under a regime of rent maximization (at $N_{1\,\mathrm{II}}$*, $Y_{1\,\mathrm{II}}$*).

*4.2.3 Aggregate demand differences under the two regimes.* See the Appendix for a detailed development of the demand to sector 2 from fishing in open access by traditional fishermen, as well as the demand from fishing under rent-maximizing policies by the industrial sector. From these two measures, an index of demand difference between the industrial regime and the traditional regime can be formed:

$$\begin{aligned} &D^*_{1\,\mathrm{II}} - D^{**}_{1\,\mathrm{I}} \\ &\quad = r[0.25(1 - m_{R\mathrm{II}})B_{\max}(1 - x_{\mathrm{II}}/B_{\max})^2 + 0.5(1 - m_{W\mathrm{II}})x_{\mathrm{II}}(1 - x_{\mathrm{II}}/B_{\max}) \\ &\qquad - (1 - m_{W\mathrm{I}})x_{\mathrm{I}}(1 - x_{\mathrm{I}}/B_{\max})] \\ &\quad = (r/B_{\max})[0.25(1 - m_{R\mathrm{II}})(B_{\max} - x_{\mathrm{II}})^2 + 0.5(1 - m_{W\mathrm{II}})x_{\mathrm{II}}(B_{\max} - x_{\mathrm{II}}) \\ &\qquad - (1 - m_{W\mathrm{I}})x_{\mathrm{I}}(B_{\max} - x_{\mathrm{I}})]. \end{aligned} \tag{22}$$

This difference depends on several parameters and their relative magnitudes. The biotechnical parameters of population growth are linked to the growth characteristics of the economy. The parameters $x_{\mathrm{I}}$ and $x_{\mathrm{II}}$ of the different technologies have an important impact upon the results as well. We postulated that $B_{\max} > x_{\mathrm{I}} = W_{\mathrm{I}}/q_{\mathrm{I}} > x_{\mathrm{II}} = W_{\mathrm{II}}/q_{\mathrm{II}} > 0$.

The economic parameters $m_{W\,\mathrm{I}}$ and $m_{W\,\mathrm{II}}$ are propensities to import from among the inputs used in fishing activities for traditional (I) and industrial (II) sectors of the fishery. The order of these values are $0 < m_{W\,\mathrm{I}} < m_{W\,\mathrm{II}} < 1$. The parameter of interest in the debates, $m_{R\,\mathrm{II}}$ ($0 \leq m_{R\,\mathrm{II}} \leq 1$), is the propensity to import unproductive services with resource rents.

The difference function defined in equation (20) is a decreasing function of $m_{R\mathrm{II}}$, so that as $m_{R\mathrm{II}}$ becomes larger the difference between the industrial sector impacts and the traditional sector impacts, which started out positive, become smaller and eventually negative.[11] Positive values suggest that the industrial sector has a greater marginal impact on the overall economy than does the traditional sector, and vice versa, as the signs change. This difference is never positive unless the import propensity for the rent, $m_{R\mathrm{II}}$, conforms to the following condition:

$$m_{R\mathrm{II}} < 1 - [(1 - m_{W\mathrm{I}})(B_{\max} - x_{\mathrm{I}})x_{\mathrm{I}} - 0.5(1 - m_{W\mathrm{II}})(B_{\max} - x_{\mathrm{II}})x_{\mathrm{II}}]/[0.25(B_{\max} - x_{\mathrm{II}})^2]. \tag{23}$$

If this parameter falls above this condition, then it is better for the managers of the economy to promote policies of open access fishing by the traditional sector. This is because the fishery exploited by an industrial sector, even if it is maximizing rents to the resource, would generate an external trade balance and growth in the rest of the economy that would be less than if the fishery were exploited by traditional fishers in a common pool setting.

Table 2 presents $D_{1\mathrm{II}}{*} - D_{1\mathrm{I}}{**}$ (the difference in aggregate demand according to whether the fishery is managed as a rent-maximizing sole owner industrial fishery or as a common pool traditional fishery) as a function of $m_{R\,\mathrm{II}}$ and the ex-vessel prices of shrimp from the traditional sector, as a percentage of the industrial weighted average ex-vessel prices. The limit values of $m_{R\mathrm{II}}$ range from zero if the export prices are 26% of the value of the industrial sector, to about 0.35 if the prices are at parity. This means that if prices are at parity in the two sectors, 40% of the resource rent would have to disappear on directly unproductive imports in order to justify policies that would favour employment in the traditional sector. Conversely, when traditional prices are at 30% of the industrial prices, 85% of the resource rents would have to disappear before this model would recommend a traditional fishery in open access. These limit values are rising at a decreasing rate from left to right. These are very gross figures, and because we are principally concerned with relative change, we have used standardized indices rather than the actual numbers. Greboval (1996), Greboval & Ranaivoson (1996), Greboval & Rakotozanany (1996) and the GAPCM reports provided earlier provide much more detail than we can treat here. We also have an arbitrary virgin biomass value and intrinsic rate of growth parameter ($B_{\max} = 100$; $r = 0.1$)[12]. The catchability coefficients are deduced from the relative productivity of the two sectors, and are $q_{\mathrm{I}} = 0.05$ and $q_{\mathrm{II}} = 1$. The unit cost estimates, again to come close to the right magnitudes, are taken from the estimates of consumption in both sectors provided by GAPCM & SEPIA (1998c). These are $W_{\mathrm{I}} = 1$ and $W_{\mathrm{II}} = 8.88$. The import propensities are estimated at $m_{W\mathrm{I}} = 0.01$ and $m_{W\mathrm{II}} = 0.32$, based upon data from these reports and from macroeconomic statistics from Madagascar. If Table 2 had given all positive or negative values over the entire range of relative prices and import propensity, there would be no reason to have a policy discussion. However, this is not the case.

**Table 2.** The marginal propensity to import using resource rents (*mr*), product prices in the traditional sector (as a proportion of industrial prices) and the comparative productivity of each sector.

| *mr* | 0.2347*PI | 0.300*PI | 0.400*PI | 0.500*PI | 0.600*PI | 0.700*PI | 0.800*PI | 0.900*PI | PI |
|---|---|---|---|---|---|---|---|---|---|
| 0.050 | 1.97 | 1.59 | 1.26 | 1.06 | 0.93 | 0.83 | 0.76 | 0.71 | 0.66 |
| 0.100 | 1.87 | 1.48 | 1.15 | 0.96 | 0.82 | 0.73 | 0.66 | 0.60 | 0.56 |
| 0.150 | 1.76 | 1.38 | 1.05 | 0.85 | 0.72 | 0.63 | 0.55 | 0.50 | 0.46 |
| 0.200 | 1.66 | 1.28 | 0.95 | 0.75 | 0.62 | 0.52 | 0.45 | 0.40 | 0.35 |
| 0.250 | 1.55 | 1.17 | 0.84 | 0.64 | 0.51 | 0.42 | 0.35 | 0.29 | 0.25 |
| 0.300 | 1.45 | 1.07 | 0.74 | 0.54 | 0.41 | 0.31 | 0.24 | 0.19 | 0.14 |
| 0.350 | 1.35 | 0.96 | 0.63 | 0.44 | 0.30 | 0.21 | 0.14 | 0.08 | 0.04 |
| 0.400 | 1.24 | 0.86 | 0.53 | 0.33 | 0.20 | 0.11 | 0.04 | *− 0.02* | *− 0.06* |
| 0.450 | 1.14 | 0.76 | 0.43 | 0.23 | 0.10 | 0.00 | *− 0.07* | *− 0.12* | *− 0.17* |
| 0.500 | 1.03 | 0.65 | 0.32 | 0.12 | *− 0.01* | *− 0.10* | *− 0.17* | *− 0.23* | *− 0.27* |
| 0.550 | 0.93 | 0.55 | 0.22 | 0.02 | *− 0.11* | *− 0.21* | *− 0.28* | *− 0.33* | *− 0.37* |
| 0.600 | 0.83 | 0.45 | 0.12 | *− 0.08* | *− 0.21* | *− 0.31* | *− 0.38* | *− 0.43* | *− 0.48* |
| 0.650 | 0.72 | 0.34 | 0.01 | *− 0.19* | *− 0.32* | *− 0.41* | *− 0.48* | *− 0.54* | *− 0.58* |
| 0.700 | 0.62 | 0.24 | *− 0.09* | *− 0.29* | *− 0.42* | *− 0.52* | *− 0.59* | *− 0.64* | *− 0.69* |
| 0.750 | 0.52 | 0.13 | *− 0.20* | *− 0.39* | *− 0.53* | *− 0.62* | *− 0.69* | *− 0.75* | *− 0.79* |
| 0.800 | 0.41 | 0.03 | *− 0.30* | *− 0.50* | *− 0.63* | *− 0.72* | *− 0.79* | *− 0.85* | *− 0.89* |
| 0.850 | 0.31 | *− 0.07* | *− 0.40* | *− 0.60* | *− 0.73* | *− 0.83* | *− 0.90* | *− 0.95* | *− 1.00* |
| 0.900 | 0.20 | *− 0.18* | *− 0.51* | *− 0.71* | *− 0.84* | *− 0.93* | *− 1.00* | *− 1.06* | *− 1.10* |
| 0.950 | 0.10 | *− 0.28* | *− 0.61* | *− 0.81* | *− 0.94* | *− 1.04* | *− 1.11* | *− 1.16* | *− 1.21* |
| 1.000 | 0.00 | *− 0.38* | *− 0.71* | *− 0.91* | *− 1.04* | *− 1.14* | *− 1.21* | *− 1.26* | *− 1.31* |

*Source of raw data:* GAPCM & SEPIA (1998b), Greboval (1996), Greboval & Ranaivoson (1996) and Greboval & Rakotozanany (1996). Negative values in italics suggest combinations of ex-vessel prices for the traditional sector and marginal propensities to import for which employment in the traditional sector would result in greater economic growth in the economy.

## 5. Discussion and Conclusions

### *5.1 Discussion*

The previous section has provided a macroeconomic analysis of a case where the issue of which policy (and sector) to favour has been explored. Using the best field data available coupled with our models, we found that the decision over which sector to favour hinges on at least two important parameters. The argument is sometimes raised during these types of debate that in countries such as Madagascar, the traditional sector probably contributes little to added value, in part because the quality of the products is not good enough to enter the more lucrative export markets, and in part because the traditional fishery is in open access. The simple model and the results in Table 2 suggest that this could be true in certain cases, but it might not always be the case. The model and the results also suggest that if the industrial sector is favoured, but this sector moves all of the rent offshore through various evasive means (in which case $M_{RII}$ is literally 1), the country may be better off living with a traditional sector in open access, and trying to improve the quality of the product. In the case of Madagascar shrimp, for example, Greboval (1996) pointed out that there might be several world market prices and several different market chains, depending upon the size and quality of the shrimp produced. Shrimp coming from collectors who buy from traditional fishermen are often sold at lower prices. Policy-makers who work in developing countries therefore face an important policy trade-off. Can quality in the traditional sector be raised sufficiently to take advantage of the benefits of demand driven by employment?

In studying this case, we discovered some facts about the public management of fisheries in developing countries that seem novel to us. First, one would think that many poor countries face clear open access conditions for their fisheries because of information and transactions costs of management. This may or may not be true. The traditional fisheries, referred to as "open access", do in fact have some institutional structures for collective or commons management at the village level, although during economic downturns these may be placed under some stress. In some other cases, such as the fisheries in Haiti, the productive capacity of the traditional sector, which is a dominant sector and which fishes mainly close to shore, might be smaller than the overall biological capacity, in which case over-exploitation is localized and close to shore. In the case of Madagascar, the government has experimented for the last 20 years with different forms of effort management, and they have had a fairly well-defined policy of "private" zonal management in the northwestern part of the country. However, these management attempts were viewed by some as unsatisfactory from an equity standpoint (Griffen *et al.*, 1998). Some economists with the World Bank and the International Monetary Fund viewed these arrangements as economically inefficient as well, because they were thought to result in situations where optimum rent extraction through competitive bidding for access to different zones could not take place. However, there was enough evidence collected from the field by Griffen that rents were captured and divided up through various means by both private and public managers. Policy changes in Madagascar subsequent to restructuring have tried to increase competitiveness and transparency within these zones and in the fishery. However, the historically dominant firms in these zones are still there, and the efficiency gains in promoting competitive bidding of access rights is far from clear, given the context. On the other hand, joint public management innovations between GAPCM and the government, such as a fisheries observatory that independently collects cost and earnings

data from the fleet and reports to both GAPCM and the government of Madagascar, have improved transparency to a degree that is seldom seen even in developed countries.

There may be an institutional preference in developing countries for arrangements between the public and the private sector that resemble rent-maximizing sole ownership, in part because it is an economic response to situations of high organizational and management costs of public management. It allows the government to transfer some or all of the management responsibility to a reliable long-term manager. It also enables the government to negotiate with and manage a limited number of large companies that can be taxed or incited to give other economic considerations to maintain their positions. The rents generated under these types of policy may be distributed to public servants as bribes, to the treasury of the country, and to the resource users. All of these groups, even those who receive bribes, can contribute to economic growth in the country by spending on both domestic goods and imported goods used in production. However, it is also reasonable to think that significant leakage could occur through the net exports equation, or by outright evasion.

The possibility of economic gain in the fishery during times of economic stress can incite small-scale fisherman to enter the fishery, and this has happened in Madagascar more recently. They, with the help of smaller export enterprises called “collectors”, as well as the chiefs of their respective kingdoms, threaten the positions of the more established industrial fishermen in Madagascar. The dominant firms argue that past agreements with the Malagasy government have resulted in zonal management of the shrimp fishery that was highly organized and economically efficient. Opponents of the industrials argued that the contributions these firms make to the country are over-rated.

This debate was and continues to be a sensitive topic in Madagascar as well as in other poor countries, precisely because of the extreme poverty of the country and the importance of fisheries resources. In our example, the Malagasy shrimp fishery accounted for more than 20% of export value from Madagascar in 1996. Therefore, the question of what fisheries policies to favour, from a macroeconomic standpoint, is an important and interesting issue in these cases.

## 6. Conclusions

We have used a hybrid macroeconomic model to explore cases where it may be advantageous for a poor country to consider the employment effects of fisheries policy, which might favour more common pool industrial structures with small-scale entrepreneurs, especially where they are organized to manage fisheries effectively in a commons setting. The model used extreme Keynesian assumptions, i.e. where price levels are not affected by changes in the labour market. These results have been extended to look at the case where policies in the fishery might have impacts on the rest of the economy, and where these more restrictive assumptions are relaxed to allow for increases in the price level of the economy as full employment is reached under a fixed exchange rate. When the extreme Keynesian assumption is relaxed, the possibility of inflationary pressures dampens the approach to full employment or potential GDP. However, our work suggests no qualitative change in the overall results. A more detailed discussion is reserved for another paper.

We were interested in the question of whether favouring commons management among traditional fishermen might not in some cases be justified from a macroeconomic standpoint. Under these restrictive assumptions, and using the best available field data

we could find from Madagascar, it appears that there may be cases where such policies would be justified, but only where the prices of the outputs in the two sectors are similar and where the propensity to import unproductive goods (or the leakage of rents outside the country) is severe in the industrial sector. Organization costs must also be considered. The transactions costs of organizing a sustainable commons initiative among traditional fishers may be important, and the costs of such initiatives may become prohibitive during economic crises. Further, our model assumes that in each case (rent maximizing, open access, or anywhere in between) these outputs are sustainable.

A commons strategy might also be recommended if the public sector is particularly weak and corrupt. If corruption and rent seeking by government officials appears to motivate much of fishery policy, and if the proceeds are essentially spent on unproductive imports or moved offshore, policies that are more oriented towards common pool management by traditional fishermen and local communities may engender economic growth, and therefore could be an improvement.

Such results call into question the pertinence of rent dissipation arguments for fisheries management. Economic inefficiencies are not necessarily implied by sector dissipation of rents. Overcapacity may be at issue. However, it is well known from the empirical work on capacity utilization as an advance indicator of growth in economies that overcapacity is an endemic feature, for a number of reasons including demographics. It is therefore incumbent on resource managers not simply to demonstrate that a fishery has overcapacity, which is likely, but that the overcapacity is excessive within some broader context, such as sustainability of the resource base.

Development economists may be tempted to promote policies in poor countries aimed mainly at capturing and concentrating rents in order to finance fiscal policy, and also to help pay off development loans. The reasons for wanting to do this are understandable (see, e.g. World Bank, 1998). Restructuring programmes are also aimed at making the public sector work better and more efficiently. However, we show that rent concentration in these situations may not always be advisable. A country may be better off simply encouraging domestic enterprises to be more competitive and efficient in a commons setting, within some well-defined parameters of sustainability. If an economy has been poor for a long period, and public management institutions have significantly weakened, our proposition seems even more justified. In these cases, standard fisheries or macroeconomic policies as might be practised in a developed country may not resolve the problem at hand. Rather, first efforts should involve retraining public managers, helping to minimize organizational and management costs of public sector management, and assisting in the re-establishment of public institutions that deserve the responsibilities of stewardship.

## Notes

[1] The authors thank Groupement des Aquaculteurs et Pêcheurs de Crevettes de Madagascar (GAPCM) for the use of some parameters from their study for this example.

[2] The standard Gordon Schaefer model assumes an aggregate production technology for the fleet $Y = f(N, X)$, where $N$ is nominal effort and $X$ is the stock of the resource. The first order differential equation with respect to time, $\mathrm{d}X/\mathrm{d}t = g(X\colon r, K)$, with the parameters carrying capacity ($K$) and intrinsic rate of growth ($r$). The sustainability condition is that $\mathrm{d}X/\mathrm{d}t = g(X\colon r, K) - f(N,X) = 0$. Note that this sustainability condition applies to all levels of exploitation, even biological overexploitation.

[3] Effort usually includes capital stock as well. However, in poor countries the ratio of labour to capital is larger, and capital in the industrial fishery is usually specific to the fishery and highly mobile. If it is displaced, it is lost to the economy entirely. Following macroeconomic convention, we concentrate on employment.

[4] The "last resort" argument for fisheries has been questioned by some authors (Béné, 2003). However, our main argument is that in poor countries the price levels in the economy do not undergo increases due to the scarcity of labour. In other words, aggregate supply is horizontal.

[5] In our example, the transactions costs of management under different regimes play an important role.

[6] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTPUBLICSECTORANDGOVERNANCE/0,menuPK:286310~pagePK:149018~piPK:149093~theSitePK:286305,00.html.

[7] Key recommendations were: (1)restructuring of the national inter-ministerial fisheries management council; (2) freezing the number of licences in the artisanal and industrial fisheries; (3) augmenting the licence fees and rationalizing the financing of the Agency; (4) establishing a viable system of fisheries surveillance; (5) strengthening the property rights to fish for industrial fishers by making the licence renewal processes less arbitrary; (6) eliminating the obligation to have land-based facilities to have a licence; (7) integrating traditional fishermen into fisheries management plans; and (8) revision of protected (no industrial fishing) zones within 2 miles of the shore or inland water baseline.

[8] To simplify the exposition, we assume that the artisanal fishers are similar to the industrial fishers. Technologically speaking, there is less difference between these groups than between them and traditional fishers. In Madagascar, artisanal fishers are operators of small motorized boats and have some form of preservation, usually icing, on board. Traditional fishers use sail dug-outs or beach seines on foot, with limited means of preservation of the catch.

[9] This is not strictly true, and we will drop this assumption in the last part of this section.

[10] If the marginal costs of employment under the two technologies are the same, then $N_{1\,\mathrm{II}} = (W_{\mathrm{I}}/W_{\mathrm{II}})N_{1\,\mathrm{I}}$, and we can then write $R_{\mathrm{II}} - R_{\mathrm{I}} = SN_{1\,\mathrm{I}}[q_{\mathrm{II}}(W_{\mathrm{I}}/W_{\mathrm{II}}) - q_{\mathrm{I}}]$. That is, rents are greater using technique II than with technique I iff $(W_{\mathrm{I}}/q_{\,\mathrm{I}}) > (W_{\mathrm{II}}/q_{\,\mathrm{II}})$.

[11] $\partial(D_{1\,\mathrm{II}}{*} - D_{1\,\mathrm{I}}{**})/\partial m_R = -0.25{\cdot}B_{\max}{\cdot}(1 - x_{\mathrm{II}}/B_{\max})^2 < 0$

[12] As a passing note, the Schaefer model is not normally used to model the dynamics of tropical shrimp. However, that specific concave functional form does not affect our main conclusions, as long as a local maximum exists.

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## Appendix: Macroeconomic Impacts Through Changes in $D_1$

The same macroeconomic assumptions are invoked as in Section 3, with the following exceptions. First, we assume that the unit cost of employment in the fishery, for each technique $W_i$ ($i$ = I, II) has a certain percentage of imports between zero and unity, and that these propensities to import are ordered as $0 < m_{W\mathrm{I}} < m_{W\mathrm{II}} < 1$. We further assume that the industrial sector would receive rents from the fishery, and the marginal import propensity for these rents $m_{R\mathrm{II}}$ ($0 \leq m_{R\mathrm{II}} \leq 1$) is different from the ones above. Rents, however they are distributed between the public sector and the industrial sector, may not be completely used for imports of productive activities.

The sector 1 demand to sector 2 from fishing is therefore:

$$D_1 = (1 - m_{Wi})W_i N_{1\mathrm{i}} + (1 - m_{R\mathrm{II}})R_i \quad (i = \mathrm{I, II}). \tag{A1}$$

The exports and trade balance equations from this sector are defined as before, so that the impact of changing $N_1$ is directly felt on aggregate demand and consequently output in the economy.

For the forms we are using, the "macroeconomic optimum" is: $\partial D_1/\partial N_{1\mathrm{i}} = (1 - m_R)f_i'(N_{1\mathrm{i}}) + (m_{R\mathrm{II}} - m_{Wi})W_i$, so at the optimum:

$$f_i'(N_{1i}^{***}) = W_i(m_{Wi} - m_{R\mathrm{II}})/(1 - m_R). \tag{A2}$$

The value $(m_{Wi} - m_{R\mathrm{II}})/(1 - m_{R\mathrm{II}}) < 1$, which implies that the marginal productivity of employment is less than $W_i$. This also implies that this level of employment is larger than the $N_{1i}*$ that maximizes rent $R_i$. There can be no correspondence of these two optimums unless $m_{Wi} = 1$, where the fishing sector exclusively imports.

If the import propensity for the rents exceeds the import propensity associated with the costs of fishing, the optimality condition implies that the marginal productivity of employment in the fishery is negative at $N_{1i}$***. In this case, the fishing sector employment that maximizes economic growth, regardless of the technique, is superior to the fishing employment $N_{1i.\mathrm{msy}}$.

We want to investigate how equations (16)–(21) in the text affect $D_1$, and consequently $Y_2$.

In the case of the traditional fishery in open access at $N_{1\mathrm{I}}$**, $Y_{1\mathrm{I}}$**, the resource rents are dissipated into the economy, and the demand from the fisheries sector is:

$$D_{1\mathrm{I}}^{**} = (1 - m_{W\mathrm{I}})W_\mathrm{I} N_{1\mathrm{I}}^{**}. \tag{A3}$$

Making substitutions for $N_{1\,\mathrm{I}}$** from equations (16)–(21), we rewrite:

$$D^{**}_{1\,\mathrm{I}} = (1 - m_{W\mathrm{I}})r(W_\mathrm{I}/q_\mathrm{I})(1 - W_\mathrm{I}/q_\mathrm{I}B_{\max});$$

$$D^{**}_{1\,\mathrm{I}} = (1 - m_{W\mathrm{I}})rx_\mathrm{I}(1 - x_\mathrm{I}/B_{\max}); x_\mathrm{I} = W_\mathrm{I}/q_\mathrm{I}. \tag{A4}$$

In the case of rent maximizing industrial techniques ($N_{1\,\mathrm{II}}$*, $Y_{1\mathrm{II}}$*), the definition of aggregate sector 1 demand under the previous assumptions is:

$$D^{*}_{1\,\mathrm{II}} = (1 - m_{W\mathrm{II}})W_\mathrm{II}N^{*}_{1\,\mathrm{II}} + (1 - m_R)R^{*}_\mathrm{II} \tag{A5}$$

Again, using equations (16)–(21) as a source of variables to substitute, we obtain:

$$D^{*}_{1\mathrm{II}} = r[0.5(1 - m_{W\mathrm{II}})(W_\mathrm{II}/q_\mathrm{II})(1 - W_\mathrm{II}/q_\mathrm{II}B_{\max}) + 0.25(1 - m_R)B_{\max}(1 - W_\mathrm{II}/q_\mathrm{II}B_{\max})^2]$$

$$D^{*}_{1\mathrm{II}} = r[0.5(1 - m_{W\mathrm{II}})x_\mathrm{II}(1 - x_\mathrm{II}/B_{\max}) + 0.25(1 - m_R)\cdot B_{\max}(1 - x_\mathrm{II}/B_{\max})^2]; x_\mathrm{II} = W_\mathrm{II}/q_\mathrm{II}. \tag{A6}$$